LMDS TRANSCEIVER
SYSTEMS PARAMETER/OPERATION
SUMMARY

PARAMETER	TI	HP	EG*	CV
Transmit Power (dBW)	-17.0	-19.6	-13.0	-23.0
RF Bandwidth (MHz)	2.5	1.0	24.0	1.0
Antenna Gain	34.0	35.0	39.0	31.0
EIRP (dBW/Hz)	-47.0	-44.6	-47.8	-52.0
EIRP (dBW/MHz)	13.0	15.4	12.2	8.0
Maximum Range (Km)	5.0	2.0	2.2	5.0
Tower Height (Meters)	30.0	15.0	20.0	30.0
Hub Spacing in HPBW (Km)	17.0	17.0	17.0	17.0
out of HPBW (Km)	68.0	68.0	68.0	68.0
Max El angle, 50% blk (deg)	5.0	5.0	5.0	5.0
Aggregate C/I (dB)	35.4	41.9	27.6	36.7
Satellite System Margin	14.5	20.0	6.7	15.8

* Includes 10 dB for rain

LMDS TRANSCEIVER
SYSTEMS PARAMETER/OPERATION
WITH RULES PARAMETERS

PARAMETER	TI	HP	EG**	CV
Transmit Power (dBW)	-10.0	-15.0	-5.2	-11.0
RF Bandwidth (MHz)	2.5	1.0	24.0	1.0
Antenna Gain	34.0	35.0	39.0	31.0
EIRP (dBW/Hz)	-40.0	-40.0	-40.0	-40.0
EIRP (dBW/MHz)	20.0	20.0	20.0	20.0
Maximum Range (Km)	5.0	2.0	2.2	5.0
Tower Height (Meters)	30.0	15.0	20.0	30.0
Hub Spacing in HPBW (Km)	17.0	17.0	17.0	17.0
out of HPBW (Km)	68.0	68.0	68.0	68.0
Max El angle, 50% blk (deg)	5.0	5.0	5.0	5.0
Aggregate C/I (dB)	23.3	23.9	22.7	21.8
Satellite System Margin*(dB)	2.4	3.0	1.8	0.9

* Satellite System Margin in excess of 20.9 dB required.

** Includes 10 dB for rain

MAXIMUM EIRP
AND
POWER CONTROL

- THE STATISTICAL ANALYSIS PROGRAM WAS CONDUCTED WITH THE RULES PARAMETERS WHICH INCLUDED A 20 dBW/MHz MAXIMUM EIRP AND POWER CONTROL ACCORDING TO THE FOLLOWING FORMULA

    $$P(dBW/MHZ) = 20 + 20 \ LOG \ d/D$$

    WHERE d = DISTANCE TO THE HUB
    D = MAXIMUM DISTANCE TO THE HUB

- C/I RATIOS OF 21.8 TO 23.3 dB WERE OBTAINED WITH A 20 dBW/MHz EIRP AND POWER CONTROL.

- STATISTICAL ANALYSIS WAS CONDUCTED FOR EIRP LEVELS OF 20 dBW/MHz, 17 dBW/MHz, AND 14 dBW/MHz.
    -ACCEPTABLE C/I RATIOS OF 20.4, 22.9 AND 25.8 DB WERE OBTAINED FOR THESE EIRP LEVELS.

- IF POWER CONTROL IS NOT IMPLEMENTED THEN LIMIT THE MAXIMUM TRANSPONDER EIRP TO 14 dBW/MHZ.

TRANSCEIVER DENSITY LIMITATIONS

- THE MOST DENSE AREA OF THE U.S. (NEW HAMPSHIRE TO GEORGIA) WAS USED TO ENCOMPASS THE SATELLITE FOOTPRINT
     -RESULTING IN 25 MILLION HOUSEHOLDS.

- WITH 80 PERCENT OF THE LOCATIONS SUITABLE FOR LMDS, (LINE OF SIGHT), A TOTAL OF 20 MILLION HOUSEHOLDS ARE SUITABLE FOR LMDS SERVICE.

- MAXIMUM RETURN LINK UTILIZATION FOR DENSITY PURPOSES IS MODELED WITH TELEPHONE CIRCUITS THAT HAVE A MAXIMUM TAKE RATE OF 25 PERCENT AND 4:1 MINIMUM CONCENTRATION,
     -RESULTING IN 1.25 MILLION ACTIVE DSO CIRCUITS.

- FOR 1.25 MILLION CIRCUITS IN 150 MHZ BANDWIDTH, THE NUMBER OF CIRCUITS PER MHZ IS 8,333.

- USING 64 KBPS AND A CIRCUIT EFFICIENCY OF 0.6, WHICH INCLUDES SIGNALING AND CONTROL,
     -RESULTS IN 890 TRANSMITTERS PER MHZ.

- INDIVIDUAL SYSTEM ANALYSIS YIELDED ACCEPTABLE C/I RATIOS WITH 14.5 TO 20 DB MARGINS.

- TRANSCEIVER DENSITY LIMITATIONS RULES ARE NOT REQUIRED SINCE SUITABLE C/I RATIO MARGINS ARE ACHIEVED USING THE MOST DENSE AREA OF THE U.S. TO ENCOMPASS THE SATELLITE FOOTPRINT.

ANTENNA ORIENTATION

THE STATISTICAL PROGRAM WAS MODIFIED TO ALLOW EVERY Nth TRANSPONDER ANTENNA
TO HAVE A RANDOM ELEVATION ANGLE FROM 0 TO 90 DEGREES.

- THE STATISTICAL PROGRAM WAS RUN WITH N = 5, 10 AND 100 WITH THE RULES PARAMETERS WITH
  20 DBW/MHZ POWER RESULTED IN THE FOLLOWING SATELLITE C/Is RESULTING.

N	% DISTRIBUTION	C/I
5	20	21.6
10	10	21.8
100	1	23.2

- RESULTS SHOW THAT ACCEPTABLE C/I RATIOS ARE OBTAINED WITH 20 PERCENT OF THE POPULATION
  HAVING MISALIGNED ANTENNAS.

- CONCLUSIONS ARE THAT INTERLOCKS ARE NOT REQUIRED TO PREVENT UNACCEPTABLE SATELLITE
  C/I RATIOS.

ANTENNA BEAMWIDTH/SIDELOBES
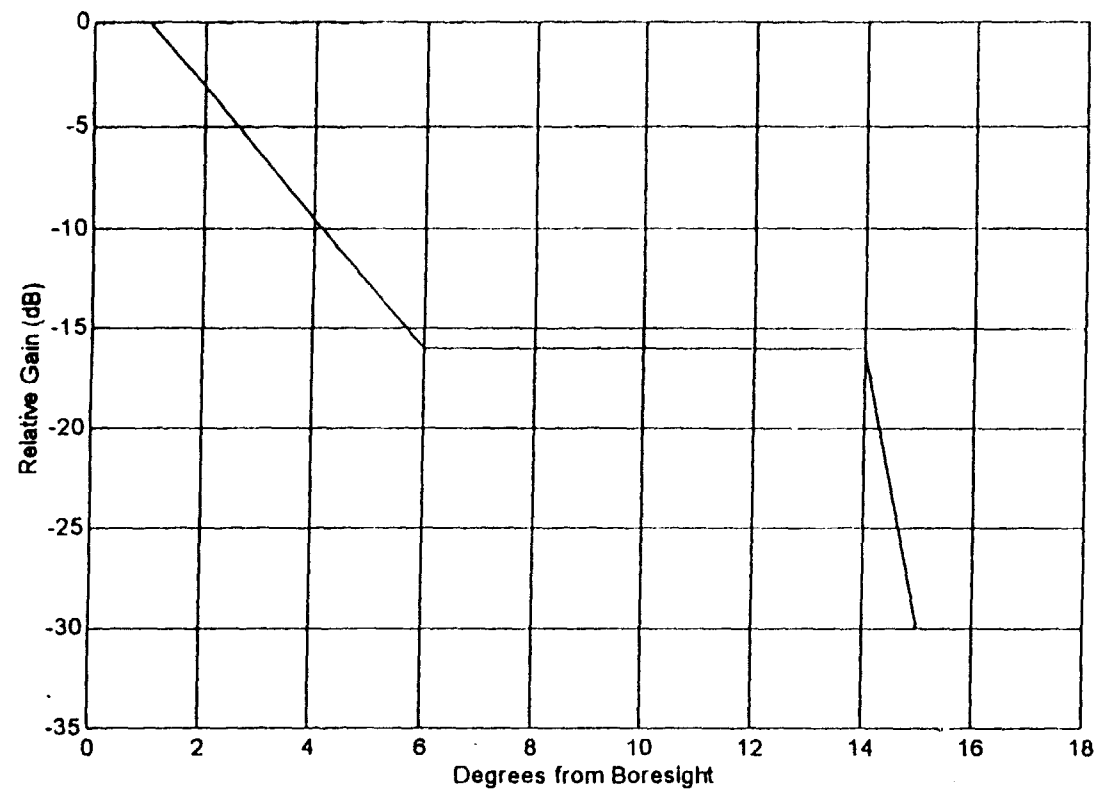
DENSITY

- SV Footprint Population Base   75 million
  NE & Mid. Atlntic
  - Households , 3 per household   25 million
  - LMOS Coverage 0.8   20 million
  - Subscribers (Take Rate, 25%)   5 million
      4:1 Concentration   1.25 million

- Subscribers per MHz for 150 MHz

$$\frac{1.25 \times 10^6}{150 \, MHz} \qquad 8333$$

- Number of Circuits per MHz
  - data rate for DS0 64 kbs
      eff. of 0.6 $\frac{1MHz}{64kbs} \times .6 = 890^*$

* Maximum loading exclusive
  of hub sectors!   "CIRCUITS AVAILABLE"

- Number of systems pointing
  in the direction of the satellite.

$$890 \times \frac{CPE \, Beamwidth}{360°}$$

$$890 \times \frac{4}{360} = 9.9 \quad \sim \quad \underline{10}$$

SATELLITE/GATEWAY PARAMETERS

- Gateway Transmitter EIRP   43.2 dBW

- Spaceloss at
  - 2747 Km, 5° EL   -182.6 dB
  - 780 Km, 90° EL   -172.6 dB

- Satellite Antenna Gain   30.1 dB

- Satellite Rec. Noise Floor, N_0 -192.5 dB

- Satellite Sig Level

	@ Ant.	@ Rec
@ 2747 Km	43.2-182.6 → -146.4	-116.3
@ 780 Km	43.2-172.6 → -136.4	-106.3

- Data Bit Rate; 1/2 Rate
  - Code rate   6.25 MB/s
  - Info rate
    - of 3.125 MBPS   -65 dB

- Satellite Receiver, E_b
  - @ 2747 Km $E_b = (-116.3)+(-65) = -181.3$
  - @ 780 Km $E_b = (-106.3)+(-65) = -171.3$

LMDS PARAMETERS

- TRANSMIT EIRP   -40 dBW/Hz

- Space Loss

     @ 2747 Km, 5° EL   -189.6 dB

     @ 780 Km, 90° EL   -179.6 dB

LMDS Sig Level		I @ SV Ant	I_0 @ SV Rec
@ 2747 Km			
-40	-189.6	-229.6	-199.4
@ 780 Km			
-40	-179.6	-219.6	-189.4

MAX RANGE / MIN SIGNAL
(2747 Km / -181.3 dB)

$E_b = -181.3$

Excess Margin
6.5 dB

-189.8

$\frac{E_b}{N_0 + I_0} R_q = 7.7 dB$

$N_0 + I_0 = -195.3$

$N_0 = -197.5$

$I_0 = -199.4$

$I_{min} = -210.5$

$\frac{E_b}{N_0 + I_0} = \frac{-181.3}{-195.3} = 14 dB$

BER > 1 × 10⁻¹³

C/I
20.7 dB

N_0/I_{min}
13 dB

MAX RANGE
MULTIPLE CPE's

- $I_0' \Rightarrow$ 10 CPE's ; 100% at max Range

$$I_0' = I_0 + 10 \, dB = -199.4 + 10 = -189.4$$

$$I_0' + N_0 = (-189.4) + (-197.5) = -188.7$$

$$\frac{E_b}{N_0 + I_0'} = \frac{-181.3}{-188.7} = 7.4 \, dB$$

$$\underline{\underline{BER = 0.8 \times 10^{-8}}} \quad \checkmark$$

- $I_0'' \Rightarrow$ 5 CPE's ; 50% blockage
  at max Range.

$$I_0'' = I_0 + 7 \, dB = -199.4 + 7 = -192.4$$

$$I_0'' + N_0 = (-192.4) + (-197.5) = -191.2$$

$$\frac{E_b}{N_0 + I_0''} = \frac{-181.3}{-191.2} = 9.9 \, dB$$

$$\underline{\underline{BER = 1 \times 10^{-12}}}$$

MIN RANGE / SIGNAL
(780 Km / -171.3)

$E_b =$
-171.3 _____

$\dfrac{E_b}{I_o + N_o}$

$\dfrac{-171.3}{-188.8} = 17.5 dB$

$I_o + N_o = -188.8$ _____

I_o
-189.4

$BER > 1 \times 10^{-\infty}$

$N_o = -197.5$ _____

$$\dfrac{E_b}{N_o + I_o} = \dfrac{-171.3}{-188.8} = 17.5 dB$$
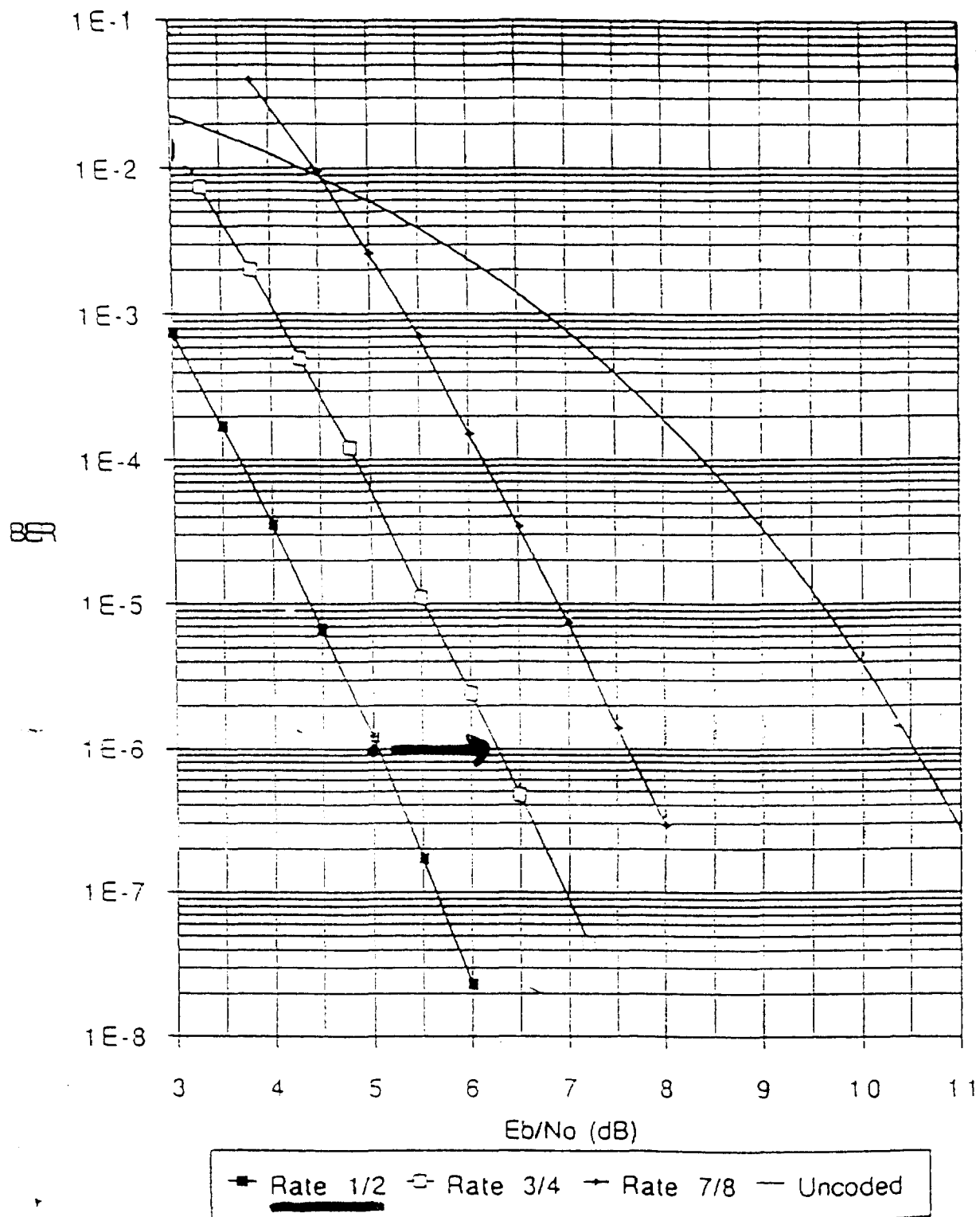
$$BER > 1 \times 10^{-\infty} \quad \checkmark$$

• $I_o' > 10 \ CPE's$
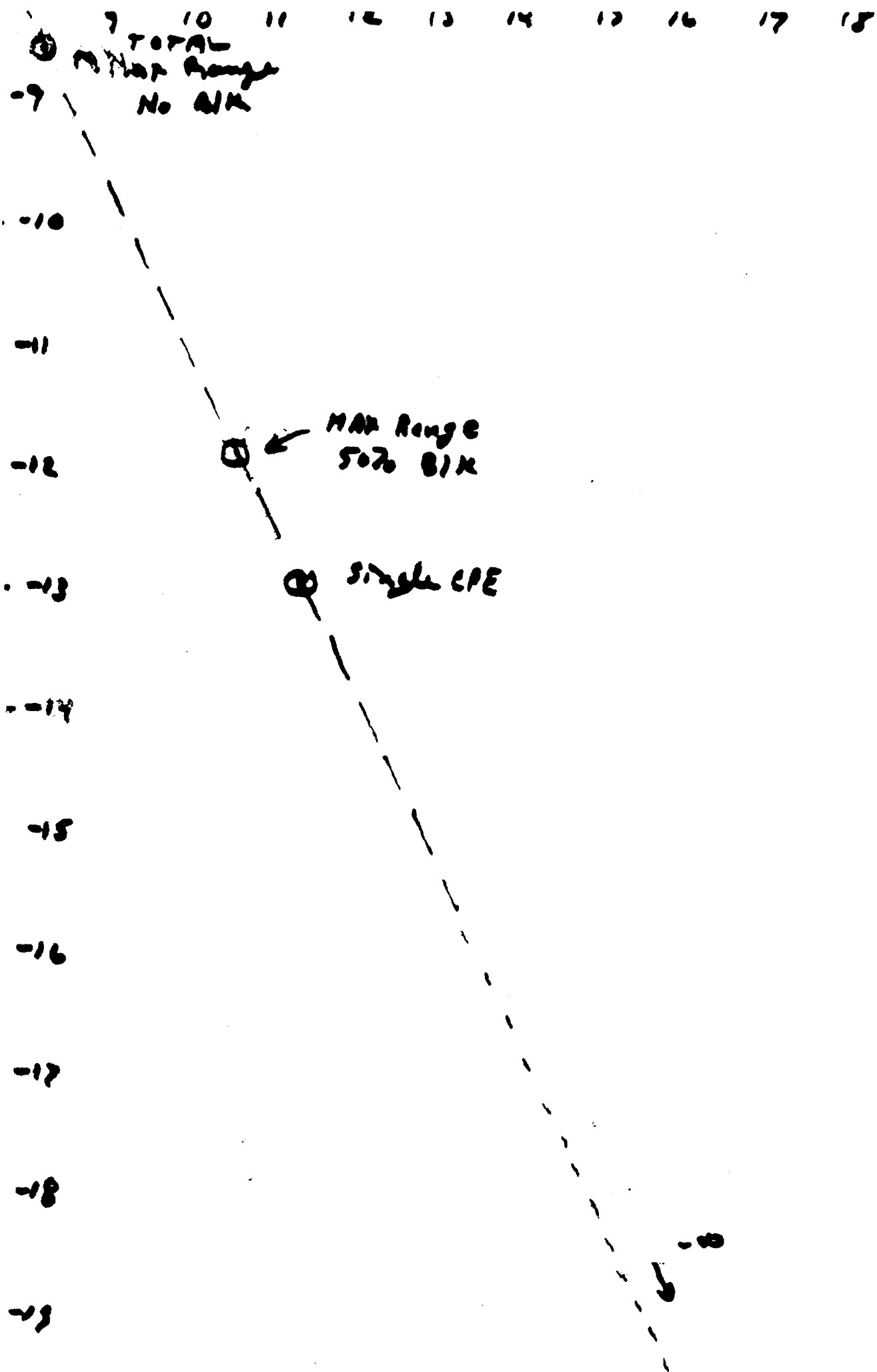
$I_o' = I_o + 10 = -189.4 + 10 = -179.4$

$N_o + I_o' = (-197.5) + (-179.4) = -179.3$

$$\dfrac{E_b}{N_o + I_o'} = \dfrac{-171.3}{-179.3} = 8 dB$$

$$BER = 0.4 \times 10^{-9} \quad \checkmark$$

BER

1E-1
1E-2
1E-3
1E-4
1E-5
1E-6
1E-7
1E-8

3 4 5 6 7 8 9 10 11

Eb/No (dB)

Rate 1/2 — Rate 3/4 — Rate 7/8 — Uncoded

Table R-A-6 (Rev 1)

SV-Gateway Links

Item		Downlink		Uplink	
		Rain	Clear	Rain	Clear
Range	km	2326.0	2326.0	2326.0	2326.0
Transmitter					
Power	dBW	0.0	-9.7	13.0	-11.8
Antenna Gain	dB	26.9	26.9	56.3	56.3
Circuit Loss	dB	-3.2	-3.2	-1.0	-1.0
Pointing Loss	dB	-0.5	-0.5	-0.3	-0.3
EIRP	dBWi	23.2	13.5	68.0	43.2
System					
Margin	dB	3.2	3.2	2.1	2.1
Space Loss	dB	-185.8	-185.8	-189.1	-189.1
Propagation Loss	dB	-14.2	-1.5	-30.0	-1.5
Polarization Loss	dB	-0.2	-0.2	-0.2	-0.2
Total Prop. Loss	dB	-203.4	-190.7	-221.4	-192.9
Receiver					
Rec. Sig. Strength	dBWi	-180.2	-177.2	-153.4	-149.7
Pointing Loss	dB	-0.2	-0.2	-0.8	-0.8
Antenna Gain	dB	53.2	53.2	30.1	30.1
Received Signal	dBW	-127.2	-124.2	-124.1	-120.4
Ts	K	731.4	731.4	1295.4	1295.4
Noise Density	dBW/Hz	-200.0	-200.0	-197.5	-197.5
Noise Bandwidth	dBHz	64.9	64.9	64.9	64.9
Noise	dBW	-135.1	-135.1	-132.6	-132.6
Link Eb/No	dB	7.9	10.9	8.5	12.2
Eb/Io	dB	25.0	25.0	16.0	16.0
Computed Eb/(No + Io)	dB	7.8	10.7	7.8	10.7
Required Eb/(No + Io)	dB	7.7	7.7	7.7	7.7
Excess Margin	dB	0.1	3.0	0.1	3.0
SPFD at GW	dBW/ m²/ 1mhz	-134.3	-131.3		

11/2/95	Name	Organization	Phone / Fax
	Jennifer Gilsenan	FCC	739-0736 / 887-6126
	HARRY NG	FCC	739-0748 / 847-6126
	Bob James	FCC	418-0748 / 418-2643
	TOM TYCE	FCC	739-0566 / 847-612
	Susan Magnotti	FCC	418-0871
	Mike Marcus	FCC/OET	739-0572 / 867-0199
	David Keir	LS+L / TRW	429-5970 / 243-7783
	PHILIP MALET	STEPTOE + JOHNSON	371-6893 / 842-3578
	BARRY LAMBERGMAN	MOTOROLA	371-6929 / 842-3578
	Jocelyn Read	FCC/IB/SRD.	739-0427 / 887-6121
	ERIC BARNHART	FOR CellularVISION	404-894-8248 / 770-962-3486
	Karl Kensinger	FCC/IB/SRD	202 739-0142 / 887-6126
	John Knudsen	Motorola	732-2965 / 732-2305
	Rob Kubik	Mot-rola	732-6016 / 732-2305
	BARY BERTIGER	Motorola	602 732-3611 / 732-2303
	Mike Kennedy	(M)	202-311-6151 / 342-3573
	Samir Kamal	HP	415.857.2294 / 415.852.8043
	Doug Gray	HP	415-857-8070 / 415-813-3759
	LELAND LANGSTON	TI	214-917-62C9
	BILL MYERS	TI	214-917-7245
	Gene Robinson	TI	214 917-6202
	Doug LOCKIE	ENDGATE	408-737-7300
	PAUL MISENER	WR+F / Texas Instruments	202-828-7506 / 202-429-7049

FCC, TEXAS INSTRUMENTS AND MOTORLA MEETING ATTENDANCE; 10 OCTOBER 1995

NAME	ORGANIZATION	PHONE
Jennifer Gilsenan	FCC	202 739-0734
Don Gips	FCC	202 418-2034
Giselle Comez	FCC	202 739-0736
Bob James	FCC	202 418-0798
Karl Kensinger	FCC	202 739-0734
Mike Marcus	FCC	202 739-0572
Susan Magnetti	FCC	202 418-0871
Tim May	FCC	202 418-1310
Harry Ng	FCC	202 739-0748
Greg Rosston	FCC	202 418-2044
Tom Tycz	FCC	202 734-0566
Eric Barnhart	CV	404 894-8248
Charles Milkis	M. Gardner-CV	202 785-2828
Doug Gray	HP	415 857-8070
Ken Engle	Motorola	602 732-2965
John Knudsen	Motorola	602 732-2965
Barry Lambergnen	Motorola	202 371-6929
Phil Malet	S&J-Motorola	202 371-6893
Leland Langston	TI	214 917-6209
Bill Myers	TI	214 917-7243
Gene Robinson	TI	214 917-6202

**An Examination of IRIDIUM Orbits and Gateway Elevation Angle—
Impact on System Availability in the Presence of LMDS Subscriber Transmitters**

November 17, 1995

This brief paper summarizes the elevation angles expected at the IRIDIUM gateway from
the earth station to the IRIDIUM satellite. This elevation angle is of interest in determining
the potential for LMDS subscriber transmitter interference into the IRIDIUM satellite uplink
receiver. The law of sines for spherical triangles is the fundamental analytical basis
applied herein.

Separation between the earth station and the satellite:

Assumptions:

- Gateway site is at mid-CONUS latitude (40 degrees North)

- Spacing of orbit planes is 31.6 degrees (actually one of six planes is at 22 degrees, so
  this is worst case)

- Inclination angle is 90 degrees (actual inclination angle is 86.5 degrees, but difference
  is trivial at assumed latitude)

With these assumptions, the great-circle angular separation of orbit planes is 24.1 degrees
at 40 degrees North latitude.

Elevation angle between the earth station and the satellite:

Given the 24.1 degree angular separation between adjacent orbits, we can now examine
the worst-case elevation angle between the earth station and the satellite.

Since the separation between satellites in a given orbit plane is about 32.7 degrees (11
satellites per orbit plane), the maximum angular separation between a gateway and satellite
when they are co-longitude is one half of 32.7 degrees, or 16.35 degrees. Given this, and
the orbit altitude of 780 km for the satellites, the worst case elevation angle to the satellite
for co-latitude situations is 13.6 degrees.

For gateway positions between orbits, the worst case (lowest) elevation angle to the
satellite occurs on a constant-latitude line halfway between the positions of the two
adjacent satellites. For this situation at 40 degrees North latitude, the worst case elevation
angle to the satellite is 11.9 degrees.

Further analysis which considers all possible positions of the satellite constellation relative
to the gateway shows the following:

Percentage of Time	Elevation Angle (θ) to Nearest Satellite (deg.)
worst 2 %	$11.9 < \theta < 13.6$
10 %	$13.6 < \theta < 15.8$
best 88 %	$\theta > 15.8$

This indicates that the elevation angle to the satellite is never below 11.9 degrees, and is only below 13.6 degrees two percent of the time. Moreover, the elevation angle to the satellite is above 15.8 degrees 88 percent of the time.

Impact on IRIDIUM Availability in the Presence of LMDS Transmitters:

As Motorola has stated, the IRIDIUM system is designed for operation of gateway feeder links at elevation angles of ten degrees or above. Further, Motorola has indicated concern about LMDS transmitters causing degradation of system availability if interference from LMDS consumes IRIDIUM power margins intended for compensation "rain and range." The availability of the IRIDIUM feeder links has not been disclosed. However, it is not necessary to know the availability to consider the impact of gateway operation at minimum elevation angles of 11.9 degrees since we know the system availability is acceptable at elevation angles of 10 degrees.

At an elevation angle of ten degrees, the range to the satellite is 2325 km. The minimum range to the satellite (at zenith) is 780 km. Thus, the power dynamic range of the system consumed by compensation for range to the satellite is 20 log(2325/780) = 9.5 dB.

Since the total power dynamic range of the uplink transmitter is +12 dBW - (-22.3 dBW) = 34.3 dB (from Motorola system summary table dated 8/5/94), the remaining 24.8 dB after the range compensation value is subtracted is for rain compensation at 10 degrees elevation.

For a slant path through rain at an elevation angle of 11.9 degrees, the length of the path through rain is 84 percent of the length of the path through rain at 10 degrees elevation. Consequently, 16 percent of the power margin is "excess." In other words, with only 0.84 X 24.8 dB = 20.8 dB for needed for rain compensation, operation at 11.9 degrees produces the same gateway link availability as the system has at 10 degrees elevation with 24.8 dB for rain compensation. Thus, 4.0 dB of the system power margin is available for compensation of other link degradation effects. That is, at full power, the link C/(N+I) is 4 dB larger than Motorola requires.

This does not even account for the additional "free-space" margin at the higher elevation angle, which would produce additional margin. Likewise, earth curvature is not considered, which would also produce an additional, although small, margin as the elevation angle increases from 10 degrees to 11.9 degrees. At 40 degrees north elevation, the freezing-point isotherm in the atmosphere is at about 4 km altitude for an assumed 99.99% availability. This isotherm level yields a slant path range through the rain of 19.4 km for the 11.9 degree elevation angle--short enough that earth curvature need not be considered.
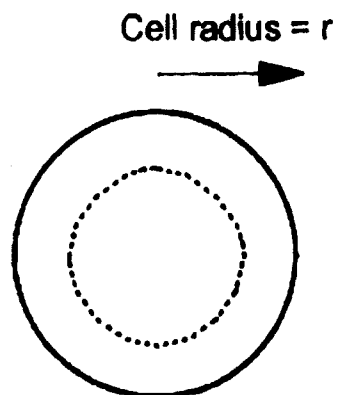
Result:

Since the "extra" 4 dB of margin is not needed to compensate for rain loss or range, the interference-to-noise can be as high as + 0.6 dB (as opposed to the -13 dB value cited by Motorola for system operation at a minimum elevation angle of 10 degrees). Viewed another way, when the interference is 0.6 dB higher than the interference (as opposed to 13 dB below the interference level with an I/N of -13 dB), the combined noise and interference would be 4 dB above the -197.5 dBW/Hz noise level in the satellite receiver. Then, with the "extra" 4 dB of margin derived from operating at or above an elevation angle of 11.9 degrees, which is not needed for rain or range compensation, the desired operating point for the Motorola satellite receiver is maintained.

Conclusion:

For gateway operation at a mid-CONUS latitude, I/N of +0.6 dB against LMDS interference is sufficient to produce the gateway link availability that Motorola states it needs. This conclusion is based on consideration of gateway elevation angle, levels of potential interference from LMDS, and the availability design of IRIDIUM to get a true picture of LMDS impact on IRIDIUM feeder link operations.

Total power spectral density is dependent only on Maximum EIRP (EIRP at the cell periphery) assuming uniform housing density

Large Cell Case

Cell radius = R

Small Cell Case

Cell radius = r

Radius for average powe 1/2 the CPEs are inside & 1/2 the CPEs are outside this radius

R /1.414

Cell Area = a = $(r/R)^2$ x A

Max EIRP = P

Avg EIRP = P/2 (assuming adaptive pwr control)

PSD/Cell = h x a x P/2

Number of cells to achieve same coverage
as large cell = A/a

Total PSD = h x a x (P/2) x (A/a)

= h x (P/2) x A

where h = housing density in households/sq-km
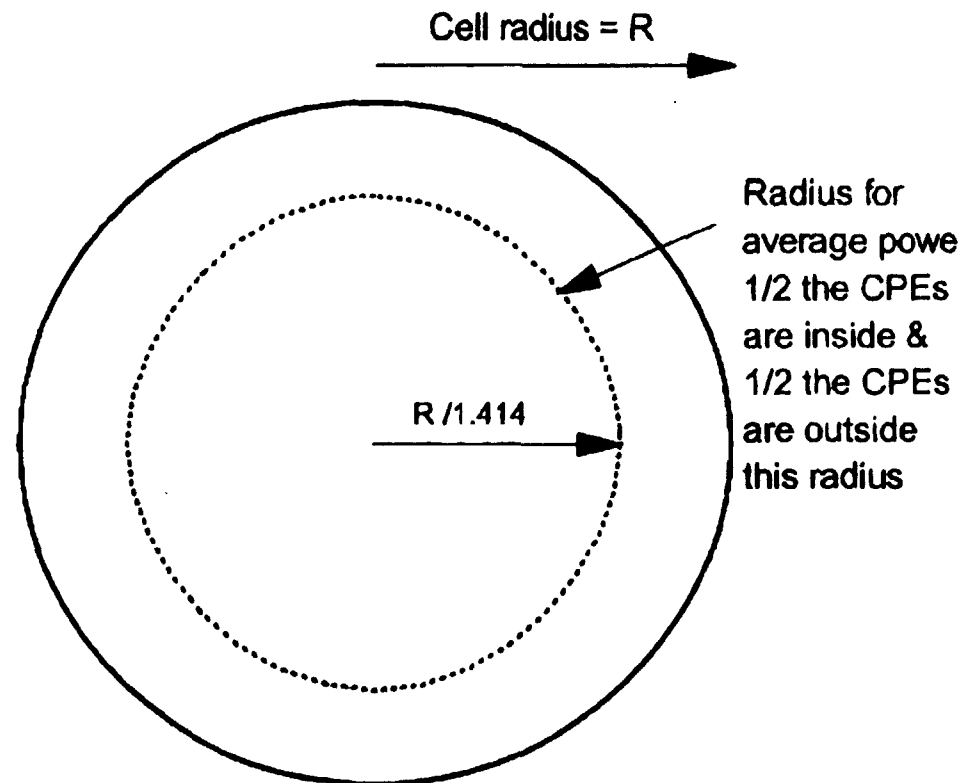
Cell Area = a = A

Max EIRP = P

Avg EIRP = P/2 (assuming adaptive pwr control)

PSD/Cell = h x A x P/2

where h = housing density in households/sq-km

D.Gray/Oct 29, 1995

Look-Up Angle vs. Hub Antenna Height
Height in Meters above CPE Antenna

D.Gray/Oct 29, 1995
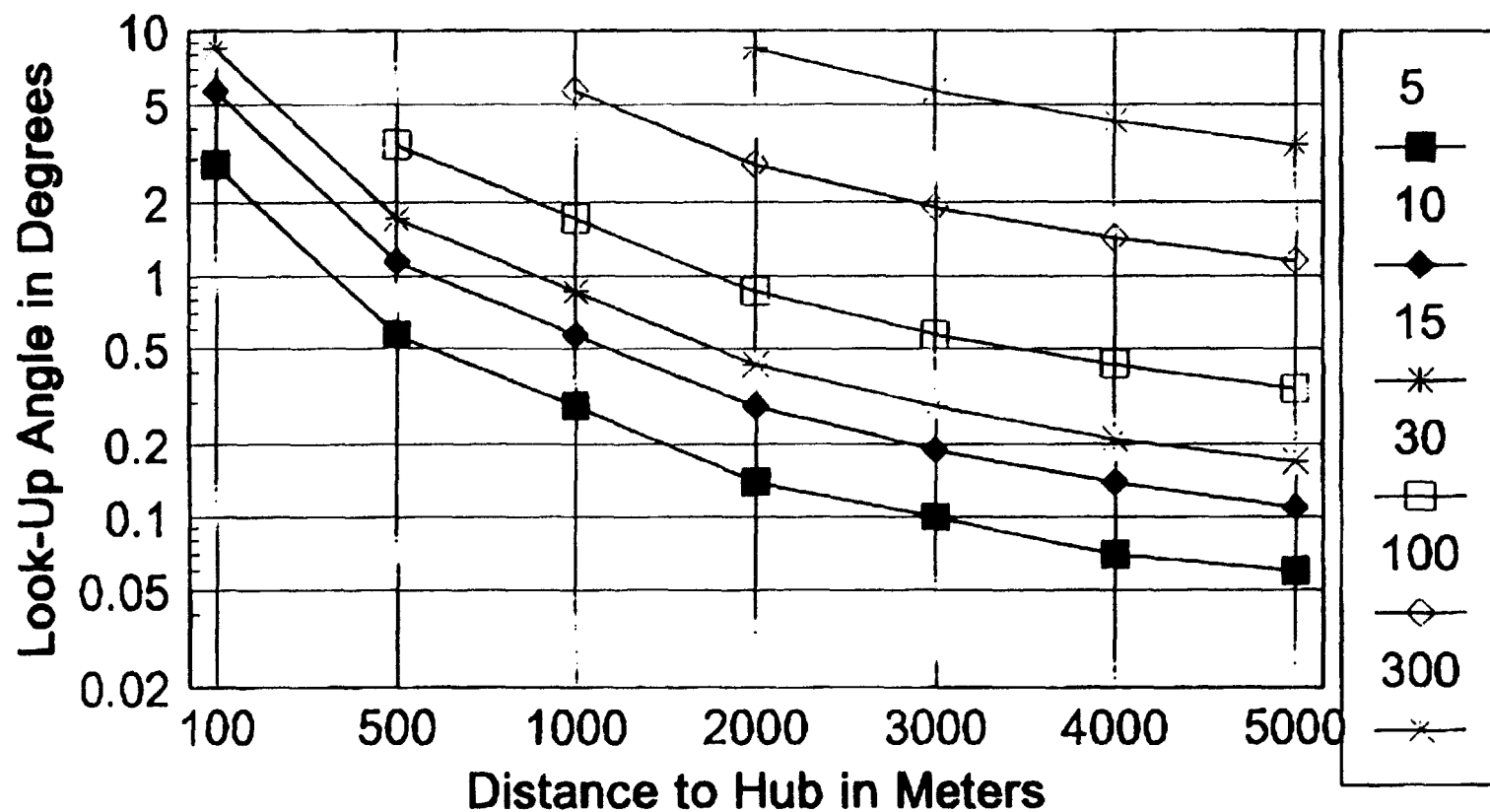
Slant Range to Satellite
(km)
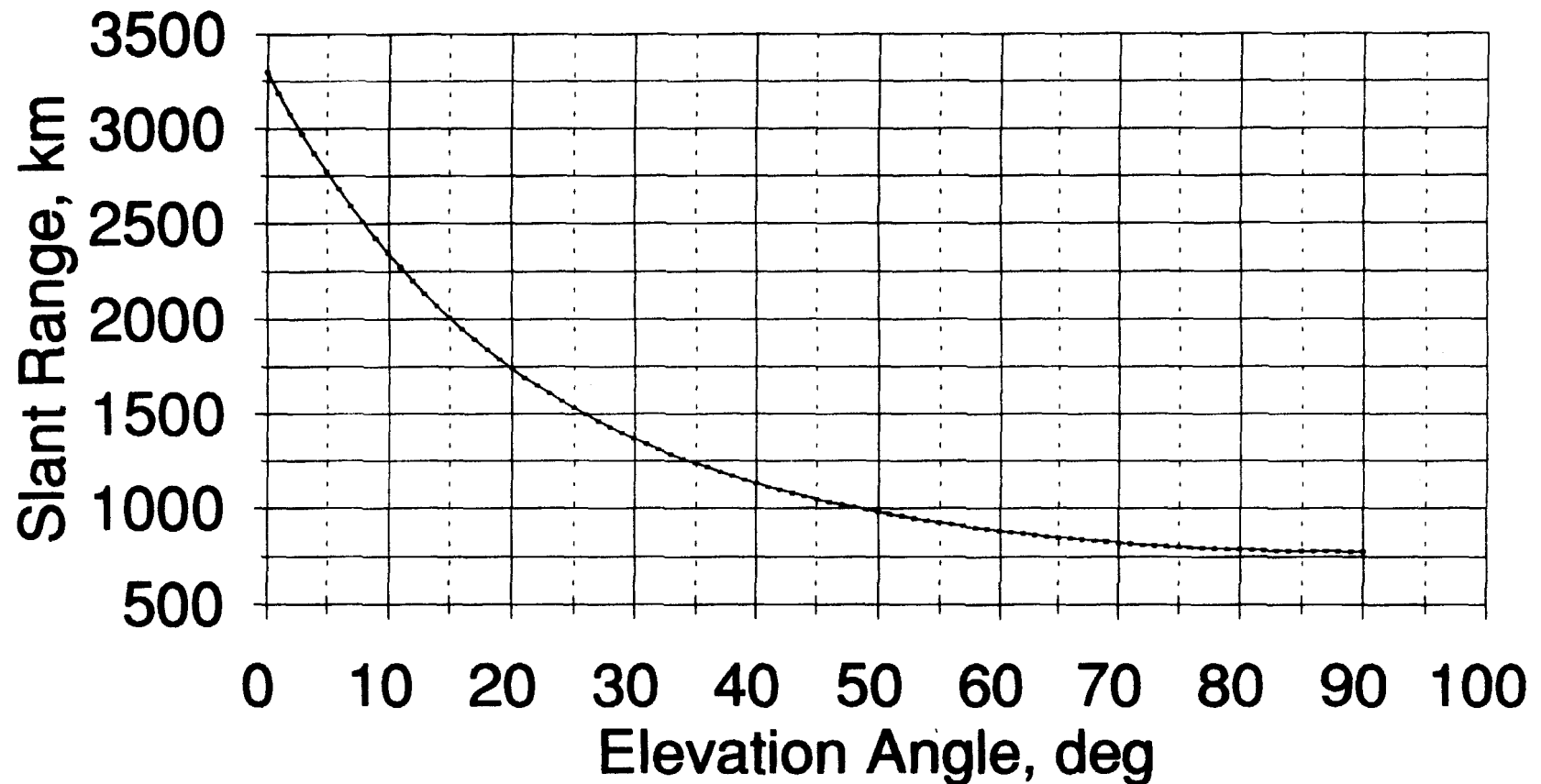
Elevation Angle, deg	Sat Angle, deg	Slant Range, km	Smax/S, dB
0	63.4198	3302.1811	0
1	63.4024	3189.0035	0.30
2	63.3501	3079.8680	0.61
3	63.2633	2974.7804	0.91
4	63.1422	2873.7281	1.21
5	62.9873	2776.6801	1.51
6	62.7992	2683.5889	1.80
7	62.5785	2594.3914	2.10
8	62.3261	2509.0106	2.39
9	62.0429	2427.3575	2.67
10	61.7296	2349.3325	2.96
11	61.3874	2274.8275	3.24
12	61.0173	2203.7275	3.51
13	60.6203	2135.9122	3.78
14	60.1975	2071.2579	4.05
15	59.7501	2009.6387	4.31
16	59.2790	1950.9277	4.57
17	58.7854	1894.9986	4.82
18	58.2703	1841.7260	5.07
19	57.7347	1790.9869	5.31
20	57.1798	1742.6611	5.55
21	56.6064	1696.6314	5.78
22	56.0155	1652.7849	6.01
23	55.4080	1611.0123	6.23
24	54.7848	1571.2091	6.45
25	54.1467	1533.2750	6.66
26	53.4945	1497.1141	6.87
27	52.8289	1462.6354	7.07
28	52.1508	1429.7521	7.27
29	51.4606	1398.3820	7.46
30	50.7592	1368.4473	7.65
31	50.0471	1339.8741	7.83
32	49.3248	1312.5928	8.01
33	48.5930	1286.5376	8.19
34	47.8522	1261.6463	8.36
35	47.1027	1237.8606	8.52
36	46.3451	1215.1251	8.68
37	45.5799	1193.3881	8.84
38	44.8073	1172.6004	8.99
39	44.0279	1152.7160	9.14
40	43.2419	1133.6917	9.29
41	42.4498	1115.4865	9.43
42	41.6517	1098.0621	9.56
43	40.8481	1081.3823	9.70
44	40.0392	1065.4131	9.83
45	39.2253	1050.1224	9.95
46	38.4067	1035.4803	10.07
47	37.5835	1021.4582	10.19
48	36.7561	1008.0294	10.31
49	35.9246	995.1690	10.42
50	35.0892	982.8530	10.53
51	34.2501	971.0593	10.63
52	33.4076	959.7669	10.73
53	32.5618	948.9559	10.83
54	31.7128	938.6078	10.93
55	30.8608	928.7049	11.02
56	30.0060	919.2308	11.11
57	29.1485	910.1698	11.19
58	28.2885	901.5073	11.28
59	27.4260	893.2294	11.36
60	26.5613	885.3232	11.43
61	25.6943	877.7762	11.51
62	24.8253	870.5770	11.58
63	23.9543	863.7148	11.65
64	23.0814	857.1792	11.71
65	22.2068	850.9607	11.78
66	21.3306	845.0501	11.84
67	20.4527	839.4391	11.90
68	19.5734	834.1195	11.95
69	18.6927	829.0840	12.00
70	17.8106	824.3256	12.05
71	16.9273	819.8376	12.10
72	16.0429	815.6140	12.15
73	15.1573	811.6490	12.19
74	14.2708	807.9373	12.23
75	13.3833	804.4740	12.27
76	12.4949	801.2546	12.30
77	11.6057	798.2747	12.33
78	10.7158	795.5305	12.36
79	9.8252	793.0186	12.39
80	8.9339	790.7356	12.42
81	8.0421	788.6786	12.44
82	7.1498	786.8450	12.46
83	6.2570	785.2325	12.48
84	5.3639	783.8391	12.49
85	4.4704	782.6630	12.50
86	3.5767	781.7027	12.52
87	2.6827	780.9571	12.52
88	1.7885	780.4252	12.53
89	0.8943	780.1063	12.53
90	0.0009	780.0000	12.53

Effects of 5% Interference Allocation

The noise temperature for Iridium satellite receiver is stated to be 1295 degrees K. The interference criteria is 5% for single service or 10% for all services (WG2/6). The required Eb/(No+Io) is 7.7 dB. These values together with the information data rate were used to calculate the receiver sensitivity.

Allowable interference based on 5 and 10% noise temperature contribution.

Parameter	Units	No Interference	5% Interference	10% Interference
Noise Temperature	degrees K	1295	1295	1295
Interference (Io)	degrees K	0	65 (-210 dBW)	129 (-207.5 dBW)
Total No+Io	degrees K	1295	1360	1424
10LOG(KT)	dB	-197.5	-197.3	-197.1
Required Eb/(No + Io)	dB	7.7	7.7	7.7
Receiver Sensitivity (Eb)	dBW/Hz	-189.8	-189.6	-189.4

The signal degradation due to 5% added system temperature is 0.2 dB. Figure 1 indicates how increased signal power compensates for increased interference. The bit error rate requirement for Eb/(No+Io)= 7.7 dB is held constant.
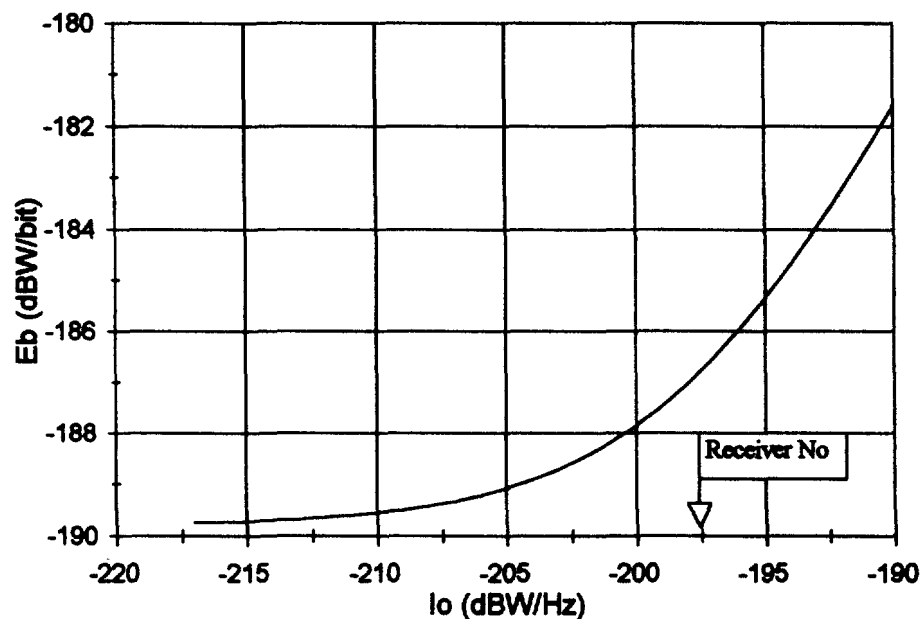

Figure 1 Required Signal Level VS Interference for Eb/(No+Io)=7.7 dB

Summary:

• An interference of -210 dBW/Hz (5% of Ts) results in a 0.2 dB power change.
• An interference of -207 dBW/Hz (10% of Ts) results in 0.4 dB power change.
• An interference of -200 dBW/Hz (10 dB increase in interference) results in 1.7 dB power change.

Conclusions:

• Only 1.7 dB power increase returns satellite to design criteria for interference levels of up to -200 dBW/Hz

• The 30 dB interference problem proposed by Motorola 2 November 1995 does not exist.